

## § 29.177

(4) The landing gear retracted; and  
(5) The rotorcraft trimmed at  $0.8 V_{NE}$  or  $V_H$ , whichever is less.

(c)  $V_{NE}$ . Static longitudinal stability must be shown at speeds from  $V_{NE} - 20$  kt to  $V_{NE}$  with—

- (1) Critical weight;
- (2) Critical center of gravity;
- (3) Power required for level flight at  $V_{NE} - 10$  kt or maximum continuous power, whichever is less;
- (4) The landing gear retracted; and
- (5) The rotorcraft trimmed at  $V_{NE} - 10$  kt.

(d) *Autorotation*. Static longitudinal stability must be shown in autorotation at—

(1) Airspeeds from the minimum rate of descent airspeed  $- 10$  kt to the minimum rate of descent airspeed  $+ 10$  kt, with—

- (i) Critical weight;
- (ii) Critical center of gravity;
- (iii) The landing gear extended; and
- (iv) The rotorcraft trimmed at the minimum rate of descent airspeed.

(2) Airspeeds from the best angle-of-glide airspeed  $- 10$  kt to the best angle-of-glide airspeed  $+ 10$  kt, with—

- (i) Critical weight;
- (ii) Critical center of gravity;
- (iii) The landing gear retracted; and
- (iv) The rotorcraft trimmed at the best angle-of-glide airspeed.

[Amdt. 29-51, 73 FR 11001, Feb. 29, 2008]

## § 29.177 Static directional stability.

(a) The directional controls must operate in such a manner that the sense and direction of motion of the rotorcraft following control displacement are in the direction of the pedal motion with throttle and collective controls held constant at the trim conditions specified in § 29.175(a), (b), (c), and (d). Sideslip angles must increase with steadily increasing directional control deflection for sideslip angles up to the lesser of—

(1)  $\pm 25$  degrees from trim at a speed of 15 knots less than the speed for minimum rate of descent varying linearly to  $\pm 10$  degrees from trim at  $V_{NE}$ ;

(2) The steady-state sideslip angles established by § 29.351;

(3) A sideslip angle selected by the applicant, which corresponds to a sideforce of at least 0.1g; or

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(4) The sideslip angle attained by maximum directional control input.

(b) Sufficient cues must accompany the sideslip to alert the pilot when approaching sideslip limits.

(c) During the maneuver specified in paragraph (a) of this section, the sideslip angle versus directional control position curve may have a negative slope within a small range of angles around trim, provided the desired heading can be maintained without exceptional piloting skill or alertness.

[Amdt. 29-51, 73 FR 11001, Feb. 29, 2008]

## § 29.181 Dynamic stability: Category A rotorcraft.

Any short-period oscillation occurring at any speed from  $V_Y$  to  $V_{NE}$  must be positively damped with the primary flight controls free and in a fixed position.

[Amdt. 29-24, 49 FR 44437, Nov. 6, 1984]

## GROUND AND WATER HANDLING CHARACTERISTICS

### § 29.231 General.

The rotorcraft must have satisfactory ground and water handling characteristics, including freedom from uncontrollable tendencies in any condition expected in operation.

### § 29.235 Taxiing condition.

The rotorcraft must be designed to withstand the loads that would occur when the rotorcraft is taxied over the roughest ground that may reasonably be expected in normal operation.

### § 29.239 Spray characteristics.

If certification for water operation is requested, no spray characteristics during taxiing, takeoff, or landing may obscure the vision of the pilot or damage the rotors, propellers, or other parts of the rotorcraft.

### § 29.241 Ground resonance.

The rotorcraft may have no dangerous tendency to oscillate on the ground with the rotor turning.

## MISCELLANEOUS FLIGHT REQUIREMENTS

**§ 29.251 Vibration.**

Each part of the rotorcraft must be free from excessive vibration under each appropriate speed and power condition.

**Subpart C—Strength Requirements**

## GENERAL

**§ 29.301 Loads.**

(a) Strength requirements are specified in terms of limit loads (the maximum loads to be expected in service) and ultimate loads (limit loads multiplied by prescribed factors of safety). Unless otherwise provided, prescribed loads are limit loads.

(b) Unless otherwise provided, the specified air, ground, and water loads must be placed in equilibrium with inertia forces, considering each item of mass in the rotorcraft. These loads must be distributed to closely approximate or conservatively represent actual conditions.

(c) If deflections under load would significantly change the distribution of external or internal loads, this redistribution must be taken into account.

**§ 29.303 Factor of safety.**

Unless otherwise provided, a factor of safety of 1.5 must be used. This factor applies to external and inertia loads unless its application to the resulting internal stresses is more conservative.

**§ 29.305 Strength and deformation.**

(a) The structure must be able to support limit loads without detrimental or permanent deformation. At any load up to limit loads, the deformation may not interfere with safe operation.

(b) The structure must be able to support ultimate loads without failure. This must be shown by—

(1) Applying ultimate loads to the structure in a static test for at least three seconds; or

(2) Dynamic tests simulating actual load application.

**§ 29.307 Proof of structure.**

(a) Compliance with the strength and deformation requirements of this sub-

part must be shown for each critical loading condition accounting for the environment to which the structure will be exposed in operation. Structural analysis (static or fatigue) may be used only if the structure conforms to those structures for which experience has shown this method to be reliable. In other cases, substantiating load tests must be made.

(b) Proof of compliance with the strength requirements of this subpart must include—

(1) Dynamic and endurance tests of rotors, rotor drives, and rotor controls;

(2) Limit load tests of the control system, including control surfaces;

(3) Operation tests of the control system;

(4) Flight stress measurement tests;

(5) Landing gear drop tests; and

(6) Any additional tests required for new or unusual design features.

(Secs. 604, 605, 72 Stat. 778, 49 U.S.C. 1424, 1425)

[Doc. No. 5084, 29 FR 16150, Dec. 3, 1964, as amended by Amdt. 29-4, 33 FR 14106, Sept. 18, 1968; Amdt. 27-26, 55 FR 8001, Mar. 6, 1990]

**§ 29.309 Design limitations.**

The following values and limitations must be established to show compliance with the structural requirements of this subpart:

(a) The design maximum and design minimum weights.

(b) The main rotor r.p.m. ranges, power on and power off.

(c) The maximum forward speeds for each main rotor r.p.m. within the ranges determined under paragraph (b) of this section.

(d) The maximum rearward and side-ward flight speeds.

(e) The center of gravity limits corresponding to the limitations determined under paragraphs (b), (c), and (d) of this section.

(f) The rotational speed ratios between each powerplant and each connected rotating component.

(g) The positive and negative limit maneuvering load factors.